INSTRUCTIONS

ENGINE MAIN FRAME AND GENERAL ASSEMBLY

GENERAL ELECTRIC 12- AND 16-CYLINDER DIESEL ENGINES

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DESCRIPTION

The main frame (Fig. 1) is the basic structural portion of the engine. It is a rigid, one-piece casting of special cast iron to which all component parts of the engine are fastened.

The top of the frame is arranged with two machined surfaces which slope away from the center ridge. Each of these surfaces has a number of bored openings to which other component parts are fitted. Core access openings in the top surfaces are sealed by steel plugs seated against copper gaskets.

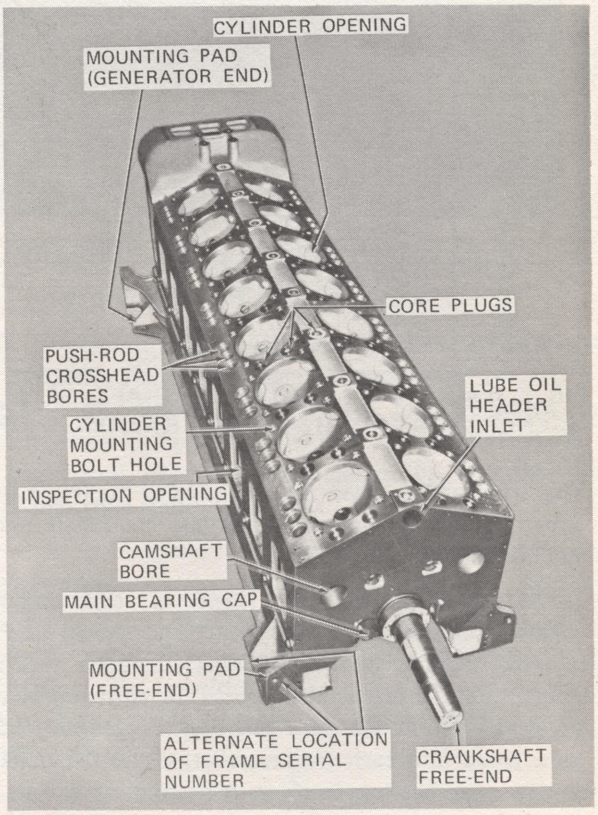
CYLINDER OPENING
MOUNTING PAD (GENERATOR END)
CORE PLUGS
PUSH-ROD CROSSHEAD BORES
LUBE OIL HEADER INLET
CYLINDER MOUNTING BOLT HOLE
INSPECTION OPENING
CAMSHAFT BORE
MAIN BEARING CAP
MOUNTING PAD (FREE-END)
ALTERNATE LOCATION OF FRAME SERIAL NUMBER
CRANKSHAFT FREE-END

FIG. 1. MAIN FRAME FREE END WITH CRANKSHAFT INSTALLED (16-CYLINDER MODEL SHOWN).

FIG. 1, E-11435B

Rectangular inspection openings, located along each side of the frame, permit access to connecting rods, main bearings and other parts contained within the frame.

A base rail structure, shown in Figs. 2 and 3, extends full length along each side of the frame. It incorporates the engine mounting pads and serves to strengthen the frame.

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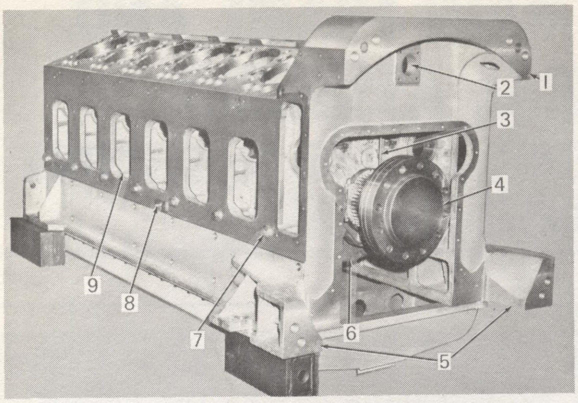
*Revisions are indicated by marginal bars.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

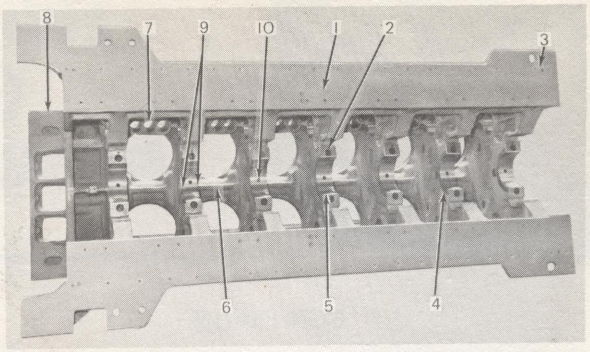
GENERAL ELECTRIC



REF.	DESCRIPTION
1	UPPER GENERATOR MOUNTING PAD
2	LUBE-OIL HEADER OPENING
3	GEAR-TRAIN OIL TUBE
4	CRANKSHAFT DRIVE FLANGE
5	LOWER GENERATOR MOUNTING PADS
6	MAIN BEARING CAP
7	MAIN BEARING CAP SIDE BOLTS
8	LUBE-OIL DIPSTICK
9	INSPECTION OPENINGS

FIG. 2. MAIN FRAME WITH CRANKSHAFT INSTALLED (GENERATOR END) (12-CYLINDER MODEL SHOWN).

FIG. 2, E-13182



REF.	DESCRIPTION
1	BASE RAIL
2	MAIN BEARING CAP POSITIONING DOWEL
3	FREE END
4	HOLLOW CROSS-MEMBERS
5	BEARING SHELL LOCK-TAB SEAT
6	CAST-IN LUBE-OIL HEADER
7	CROSSHEAD BORES
8	GENERATOR END
9	GROOVES FOR THRUST BEARINGS
10	MAIN BEARING OIL FEED HOLE

FIG. 3. INTERNAL CONSTRUCTION OF MAIN FRAME (12-CYLINDER MODEL SHOWN).

FIG. 3, E-13183

This arrangement leaves the underside of the frame free of structural members, thus simplifying crankshaft removal and installation.

Hollow cross-members (used in early-production engines), located inside the frame and shown in Fig. 3, support the crankshaft and further strengthen the frame; ribbed, solid cross-members (used in current-production engines) perform the same function. Forged-steel bearing caps, fitted into each cross-member, secure the crankshaft and its main bearings in place. A bearing cap and its main stud bolts are shown in Fig. 4. Two side bolts extend from opposite sides of the frame into each bearing cap to further secure the cap and strengthen the frame structure.

Surfaces at the ends, sides, and bottom of the frame are milled flat to form an oil-tight seal with their respective covers. The oil pan is accurately fitted to the main frame to form an oil-tight seal with the free-end cover.

A serial number is stamped on the right corner of the pan at the free end of the engine. This number, which agrees with the frame number, identifies the pan with the main frame.

One end of the frame has three extended surfaces to which the generator fastens. The generator is secured in place by eight bolts and is accurately positioned by two dowel pins in the upper extension.

Drilled and cast-in passages throughout the frame conduct lubricating oil to each engine bearing. A main oil-supply header extends lengthwise through the top ridge of the frame. Vertical oil passages extend downward from the supply header at each main bearing location. When cleaning the frame, access to these passages may be gained through plugged openings in the center ridge. Angularly-arranged oil passages, in each end of the frame, connect the No. 1 and No. 7 camshaft bearings of each bank of the 12-cylinder engine to the main supply header (for the 16-cylinder engine, the No. 1 and No. 9 camshaft bearings).

Other angularly-drilled oil passages extend from each set of cross-head bores to the adjacent camshaft bearing bore toward the free end of the frame. Drilled passages, located along the top outer edge at each side of the frame, connect each cylinder fuel drain to its respective drain header pipe.

FRAME SERIAL NUMBER

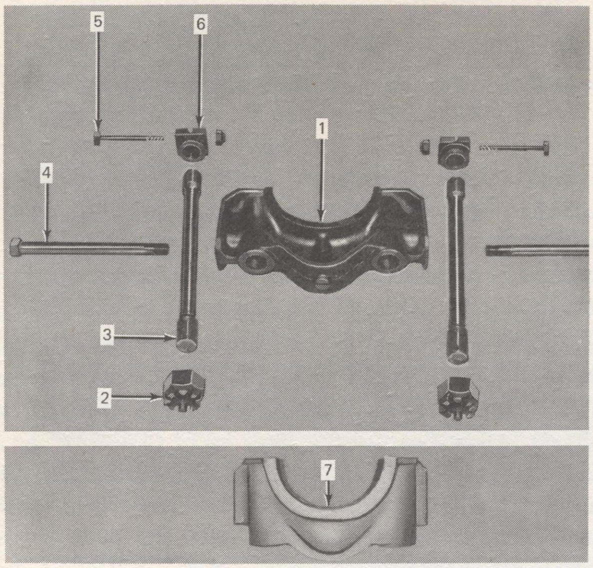
Each frame is identified by a serial number which is located on the machined face of the mounting pad or on the side of the rail at the free end, right corner of the engine (see Fig. 1). This number should always be included when making reference to a particular engine frame.

MAIN BEARING SEATS (See Fig. 5)

Main bearing seats are line-bored to give accurate bearing and shaft alignment. During the boring operation, the main

FIG. 4, E-11438D

FIG. 5, E-9921A



REF.	DESCRIPTION
1	BEARING CAP, OLD STYLE
2	LOWER NUT
3	STUD BOLT
4	SIDE BOLT
5	LOCK BOLT AND NUT
6	UPPER NUT
7	BEARING CAP, NEW STYLE

FIG. 4. MAIN BEARING CAP ARRANGEMENT.

bearing caps are bolted in place, and the bolts are tightened to their specified stretch value for machining (see DATA section, Machining Bore).

Each bearing cap is mated to one specific location in the frame. This matching number is stamped on the outside of the frame near each bearing-cap side bolt. Each cap is correctly positioned in its seat by a single dowel hole which is located in the upper, right-hand face of the cap. On older frames, two diagonally-opposite milled slots, one in the bearing cap and one in the bearing saddle, locate and lock the bearing halves in place. Current-production frames have one slot in the saddle and two slots in the cap. See BEARING CAP MODIFICATION section.

Should a bearing cap become damaged beyond use, it will be necessary to return the main frame to the factory so that a new cap may be fitted. An accurate line-boring operation is required when fitting a new cap.

BEARING CAP IMPROVEMENTS

Current-production engines are being assembled with a new style main bearing cap. It has an increased cross-sectional area with larger fillet radii in critical sections (see Fig. 4). The older style bearing cap has studs 18-3/4 in. (476,25 mm) long, Part 115X1987-1; these studs were used with the older caps on main frames prior to frame Serial No. 7205001. The newer caps use longer studs, 19-9/16 in. (496,89 mm) long, Part 115X1987-2, and are found on main frames with Serial No. 7205001 and higher. However, the longer studs can be used interchangeably on either the old or new style main bearing cap.

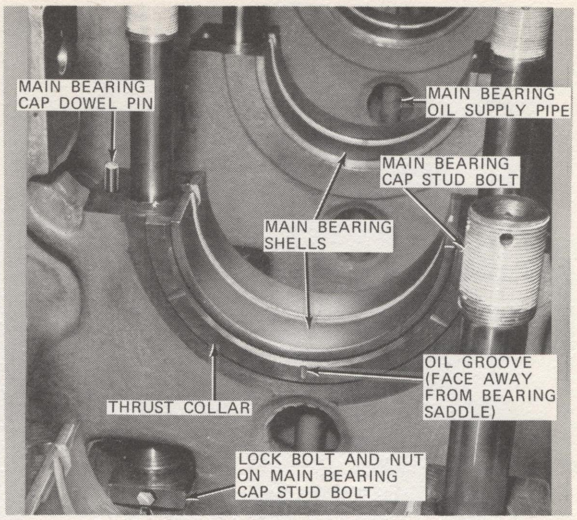

MAIN BEARING CAP DOWEL PIN
MAIN BEARING OIL SUPPLY PIPE
MAIN BEARING CAP STUD BOLT
MAIN BEARING SHELLS
OIL GROOVE (FACE AWAY FROM BEARING SADDLE)
THRUST COLLAR
LOCK BOLT AND NUT ON MAIN BEARING CAP STUD BOLT

FIG. 5. THRUST- AND MAIN-BEARING ARRANGEMENT.

CAUTION: *Do not use the shorter 18-3/4-in. studs with the new style bearing caps, since not enough thread length exists to properly tighten the cap nuts. Their use could result in failure of stud threads and in possible severe damage to engine frame and components.*

An improved stretch gage, Part 147X1860, is available to check stud stretch for both the 18-3/4- and 19-9/16-in. studs. Shops which already have stretch gage Part 147X1305 for use with the shorter stud only can order a new arm, Part 147X1877, which will allow the Part 147X1305 gage to measure stretch on the longer 19-9/16-in. stud. Refer to the Tool Catalog for details.

CORE PLUGS

Core openings in the top surface of the frame, used during manufacture, are sealed by steel core plugs. These plugs contain a 1-in. square wrench opening and are seated against soft-copper gaskets. Core plugs, other than those removed from the oil header during frame cleaning, should not be disturbed unless they are found to be leaking oil. In such a case, the copper gasket should be renewed and the plug replaced and tightened to the torque value listed in the DATA section.

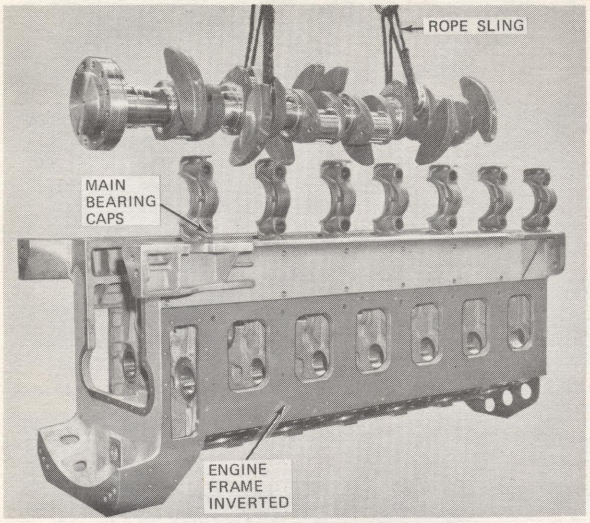


FIG. 6. INSTALLING THE CRANKSHAFT.

FIG. 6, E-13184

NOTE: *Assemble gaskets with the all-copper face in contact with the plug face; the copper-asbestos face in contact with the frame.*

THREAD INSERTS

Most cylinder mounting-bolt holes contain a steel thread insert, an adapter used during the change-over from the obsolete cylinder holddown studs to the currently-used cylinder mounting bolts. Each insert is secured by a lockwasher at the inner end. A special insert wrench, Part 147X1322, is required to remove or install the inserts. Consult the tool catalog for information on this tool. When installing a new insert, use a liberal coating of high-pressure lubricant on the external threads of the insert. Tighten the insert to the torque value specified in the DATA section.

Some main frames did not utilize steel thread inserts. If one of the mounting bolt holes should incur thread damage, it can be rebored and tapped to 1-5/8 in.-12 thread, and the steel thread insert then may be used.

CRANKCASE CLEANING (ENGINE ASSEMBLED)

The engine crankcase should be cleaned thoroughly after work has been performed which required the crankcase to be exposed. Dirt and other foreign material, if permitted to remain in the crankcase, may be drawn into the lubricating-oil system during operation, thus causing extensive damage.

Cleaning can be done best by using a spray gun with an extended brass atomizing nozzle and a good industrial cleaning solvent.

CAUTION: *Do not use solvents which will remove paint from the crankcase.*

WARNING: *Solvents may be toxic or flammable and cause harmful or fatal injury. For safety, use only with adequate ventilation; avoid contact with skin; avoid inhalation of fumes; and do not expose to flame or sparks.*

Remove all crankcase inspection covers and open the crankcase and free-end-cover drain valves. Place a container under the crankcase drain to collect used solvent. Thoroughly spray all accessible interior surfaces with solvent. Allow time for the spray vapor to dissolve the dirt and oil, then wipe the surfaces (including the oil pan) clean, using clean, lint-free cloths. Remove any foreign objects such as discarded gaskets, nuts, bolts, and parts of cotter pins found in the crankcase.

CRANKSHAFT REMOVAL

PREPARATION

The crankshaft should be removed from the main frame during major reconditioning of the engine, to permit cleaning of the frame and to allow thorough inspection of the crankshaft. Before attempting to remove the crankshaft from the engine, all major components such as cylinders, pistons and connecting rods, turbocharger, intercoolers, traction generator, end covers and oil pan must be removed from the frame. After all components have been removed, place the frame on the floor in an inverted position, as shown in Fig. 6. Use adequate wood blocking to support and level the frame.

REMOVING CRANKSHAFT

With the pump drive gear and vibration damper removed, proceed as follows:

1. Remove the bearing-cap side bolts.
2. Loosen and remove the lower nuts from the bearing-cap stud bolts. Refer to the Tool Catalog for wrenches used to perform this operation.

NOTE: *Cotter pins are no longer used to secure these nuts; tightening the nuts to stretch the stud bolts to the values specified in the DATA section will secure these nuts adequately.*

NOTE: *To facilitate removal of the bearing caps from the frame, spread the frame slightly, using frame expander, Part 147X1314 (mechanical) or Part 147X1742 (hydraulic).*

3. As the bearings are removed, record the serial number and location of each bearing shell. Carefully remove the caps, lower bearing shell, and each half-ring thrust collar. Store these parts in a safe place to prevent damage.

4. Apply lifting slings to the shaft. If steel cable slings are used, adequate protection, such as rubberized fabric hose or other suitable material, must be applied between each cable and the crankshaft to protect the shaft from damage. Guide the shaft as it is lifted from the frame. See CRANKSHAFT AND MAIN BEARINGS for the method of supporting the crankshaft, and for shaft maintenance instructions. Wrap all bearing surfaces and other exposed machined surfaces with protective, oiled paper immediately after the shaft is removed from the engine.

5. Remove the upper bearing shells and the bearing-cap stud bolts from the frame and store them in a safe place. For bearing inspection, see CRANKSHAFT AND MAIN BEARINGS.

FRAME CLEANING

The frame, end covers and governor-drive gear housing should be cleaned thoroughly. Cleaning can be done best by immersing the parts in an alkaline cleaning solution. See the DATA section for recommended cleaners. A portable steam cleaner may be used where cleaning facilities are limited.

Thoroughly clean all oil passages in the frame and end covers. If necessary, remove the plugs over each vertical bearing passage to gain access to the vertical passages and main header. It may be necessary to force a small wire brush through each oil passage to dislodge accumulated sludge which cannot be flushed out.

After cleaning is completed, rinse the frame and other parts with clean water and allow them to dry thoroughly. Protect bare metal surfaces from rust.

NOTE: *If some time will elapse before the cleaned parts are reassembled, place plastic or paper covering over these parts to protect them from dirt and dust.*

FRAME INSPECTION

After the frame is cleaned, it should be inspected thoroughly for evidence of damage as follows:

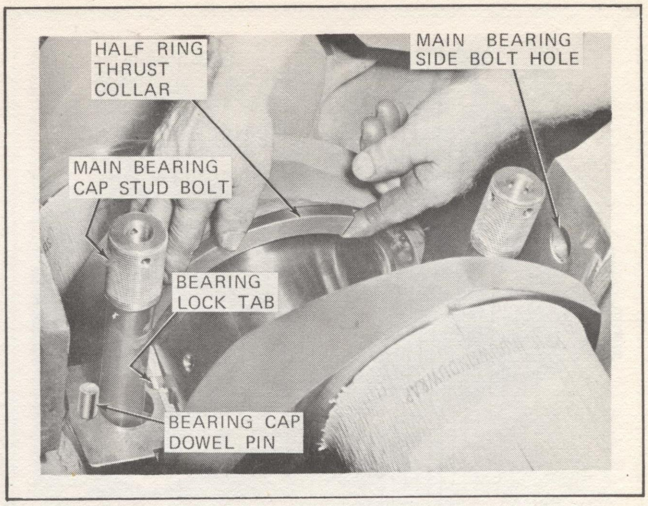


FIG. 7, E-9914A

FIG. 7. INSTALLING THE CRANKSHAFT THRUST COLLARS.

1. Visually check for cracks, nicks, burrs, scratches, signs of overheating or excessive wear, damaged threads, damaged or loose dowels, signs of fretting or galling, and any conditions which might cause leakage at gasket sealing areas.

2. Use a dye-penetrant or magnetic-particle inspection method to detect cracks in the mounting feet, corners of the camshaft gear openings, inside the camshaft gear openings, around the dovetail above the lube-oil gallery at the forward end, and the bearing-cap stud bolts and bearing-cap side bolts.

3. If, during inspection, a damaged bearing bore is found, an alignment measurement check should be made. Distorted bearing, crosshead, or cylinder-seat bores may be caused by overheating or abnormal wear. Measure the diameter of each bore at different points (see NOTE below), taking the average of at least six readings. See the DATA section of this publication.

NOTE: *When taking bore measurements without bearing shells, use machining bore stretch value for cap nuts.*

4. Check all the bearing oil tubes to verify they are tight (older frames only).

5. Check the width of the main bearing saddle at the thrust bearings. See DATA section.

Most damaged main frames are repairable either locally or at the factory. Consult the local General Electric Field Service Representative for details.

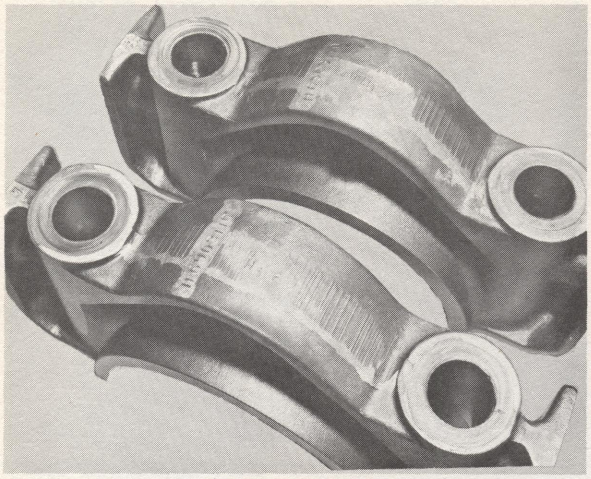


FIG. 8. CAPS WITH TRIM DIE MARKS.

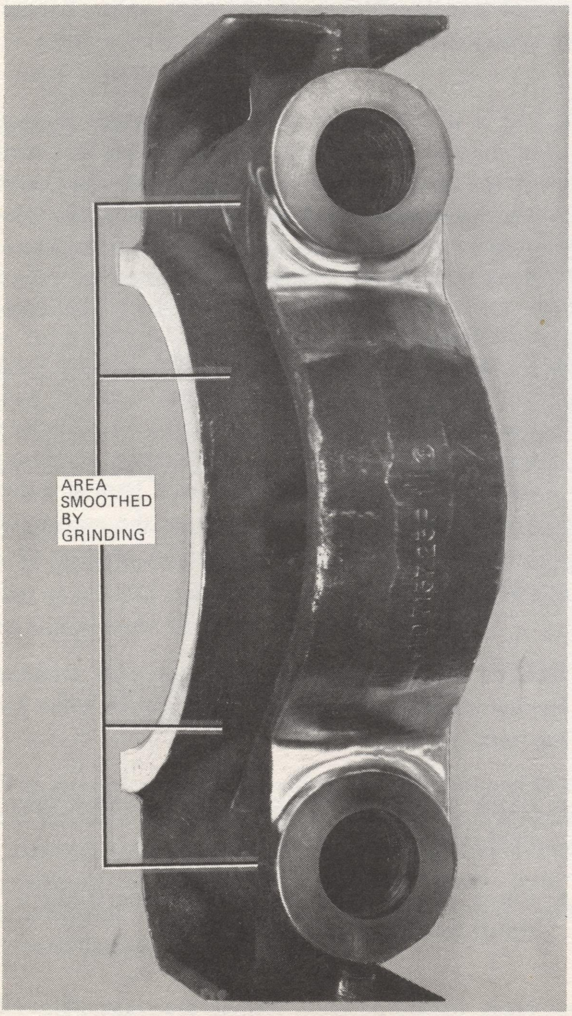


FIG. 9. GROUND CAP.

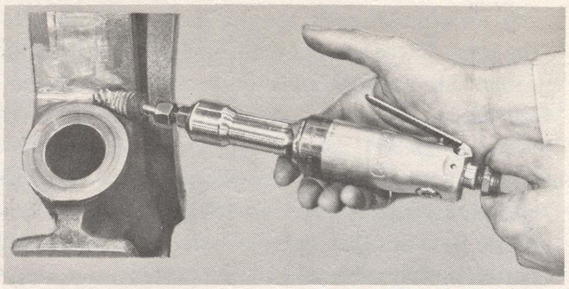


FIG. 10. SUGGESTED PNEUMATIC-TYPE TOOL*.

PAINTING FRAME INTERIOR

Since the pores of the metal are impregnated with lubricating oil, the painting of the interior surfaces of the main frame, end covers and governor drive gear box is not recommended.

BEARING CAP INSPECTION

Whenever the older style main-bearing cap is removed for any reason, such as engine overhaul, bearing replacement, or other cause, the surface finish of the non-machined areas of the caps should be inspected and improved by grinding. Some older caps have been found to have less than an acceptable finish because of worn trim dies used to remove the flash produced in the forging of the caps.

Specifically, grind out imperfections in the 1/4-in. radii just inboard of the 3-in. bosses on which the nuts seat and for a distance of 1 in. or more up the 45-degree tangent surface toward the centerline, for the full width of the cap. Be sure to grind up next to the bosses on both sides. Achieve a 63-microinch surface smoothness, which is the original finish of the face of the nut seats on the bosses.

Caps with typical imperfections are shown in Fig. 8. Fig. 9 shows a bearing cap that has had the recommended grinding. Grinding technique and tools are indicated in Fig. 10.

NOTE: *While grinding is the recommended method of improving the surface finish of caps, fine-cut files also could be used, providing the filed finish is polished with emery paper.*

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*Grinder: Stanley Model 630L, or equivalent.
Stone: Full-taper cone, No. 150 grit, and mandrel – Even Cut Abrasive Co., 8212 Carnegie Ave., Cleveland, Ohio, or equivalent.

FIG. 8, E-17679

FIG. 9, E-17680

FIG. 10, E-17681

FIG. 11, E-24226

FIG. 12, E-24227

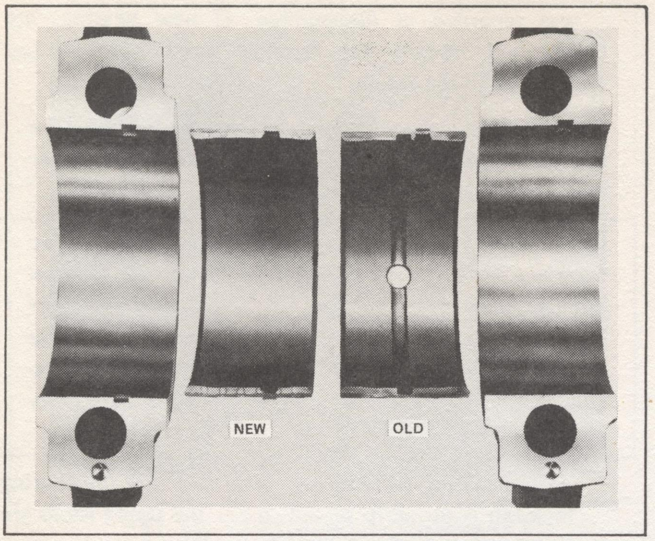

FIG. 11. GROOVELESS LOWER MAIN BEARING CAP WITH TWO LOCATING SLOTS ARE SHOWN ON THE LEFT. OLD-STYLE GROOVED BEARING AND CAP WITH ONE SLOT IS AT RIGHT.

Before reassembling in the engine, verify each cap is free from any possible cracks by magnetic-particle inspection. A crack to a depth of 1/8 in. (3,18 mm) or less will not disqualify the cap if the crack is fully removed by grinding with appropriate blending of the edges. Caps with deeper cracks must be replaced, which requires line-boring of the engine frame.

BEARING CAP MODIFICATION

Grooveless, main bearing shells are used in the lower position of all current-production engines.

Absence of the groove results in a thicker oil film and lower unit-area loading.

With this thicker film, the engine is more tolerant of microscopic-size dirt particles – particles so small that no practical oil filter can remove them. (Dirt particles carried in the oil are the primary cause of bearing wear.)

The thicker film provides more tolerance for degraded oil conditions and also compensates for slight variances in the crankshaft and bore alignment. Thus, there is less chance of metal-to-metal contact as the shaft rotates.

Another benefit of the new design is higher oil pressure. Gage in the operator's cab should now register 10 to 15 psi higher when oil is at normal operating temperature and engine is at full speed.

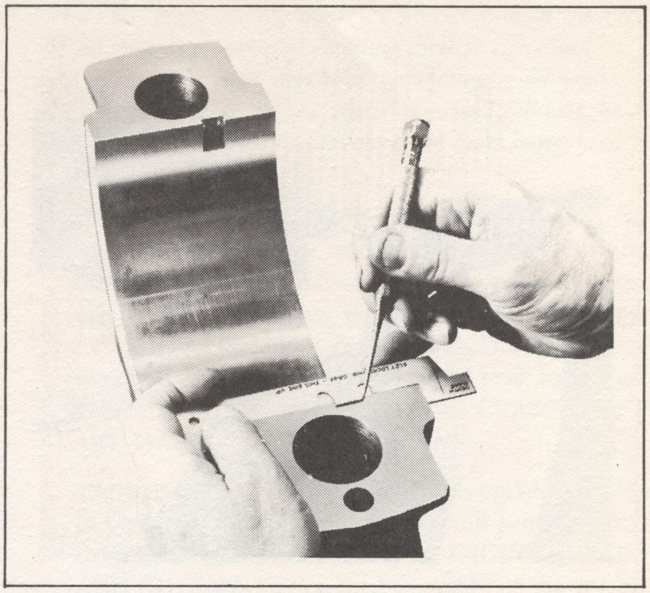

FIG. 12. SCRIBING LOCATION FOR SECOND SLOT.

CAUTION: *Under no circumstances should a grooveless bearing be installed in the upper position! With all oil to that journal blocked off, the engine can be expected to fail in only a few revolutions of the crankshaft.*

To prevent inadvertent installation in this upper position, two locating tabs are provided on each shell of the grooveless bearing. The conventional grooved bearing shell has only one such tab, as shown in Fig. 11.

Upper bearing seat in the main frame has only one locating slot. Grooveless bearing (with two locating slots) will not fit in that location.

The main bearing caps, however, must also have two locating slots to accommodate the two tabs. Caps on new diesel engines have both slots. The second can easily be added to the caps on old engines.

ADDING THE SECOND SLOT

To add the second locating slot for a grooveless bearing shell, follow this procedure:

Use Part 147X2123 template to mark the position of the second slot in a main bearing cap.

Apply the template as shown in Fig. 12 and scribe around the tab. Then, cut the slot. If several caps are to be done at once, consider a milling machine with a 3-in. diameter by 0.500 in. thick (or slightly wider) cutter. Alternatively, a hand grinder or even a file may be used.

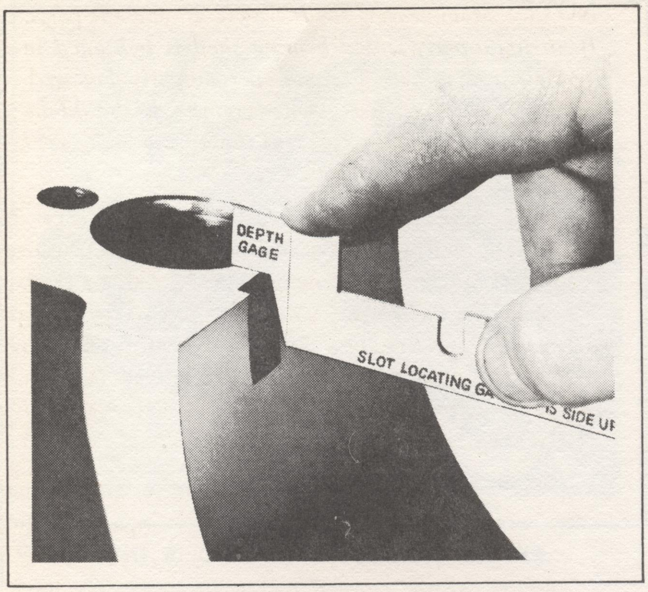

FIG. 13. MEASURING DEPTH OF SECOND SLOT.

FIG. 13, E-24228

The second (added) slot must be directly across from the original. Use this original slot as a locating and dimensional guide.

With the end of the template, check the new slot for adequate depth as shown in Fig. 13.

Don't be concerned if the new locating slot is cut slightly oversize, either in width or depth. This will do no harm unless so grossly oversize that cap strength is affected.

Cutting the slot undersize or out of location, however, will cause the grooveless lower main to bind when installed and perhaps lead to early bearing or crankshaft distress.

CRANKSHAFT INSTALLATION

1. Place the main frame on the floor in an inverted, level position, as described for crankshaft removal.
2. Assure all bearings, bearing caps, bearing saddles, thrust-collar seats and thrust collars are in good condition and are free of nicks, burrs or paint on their mating surfaces. If nicks or burrs are found, they must be removed, using a fine mill file.
3. Install the bearing-cap stud bolts with upper nuts and lock bolts. Position the upper nuts so that equal threads will extend from both the upper and lower nuts. Apply rubber boots, or other means of protection, over the No. 1 and No. 7 12-cylinder engine (No. 9 on 16-cylinder engine) main-bearing studs to protect the shaft during installation. Install the upper half of each used main-bearing shell in its proper location according to its serial number, which was recorded at disassembly. If new bearings are installed, record the bearing serial number and location in the frame.

NOTE: *New grooved main-bearing shell halves are not mated and, therefore, can be installed with either half up and at any location.*

CAUTION: *Grooveless main bearing shells are installed in the lower position on current-production engines and are available for application in older engines. These shells must be used only in the lower-half location; if applied in the top-half location, they will block off the supply of lube-oil to the bearing.*

Assure mating surfaces are clean and that the bearing lock-tab is properly seated. After the upper shells are in position, apply a liberal coating of clean engine lube oil to the bearing face.

CAUTION: *Do not apply oil between the bearing shell and saddle, as it may prevent the bearing shell from seating properly.*

4. Lift the crankshaft, using a sling arrangement as shown in Fig. 6. Align the shaft over the frame and check that journal surfaces are clean; then, lower the shaft into position.
5. Install the half-ring thrust collars as shown in Fig. 7. They are located at each side of the No. 6 12-cylinder engine (No. 8 on 16-cylinder engine) main bearing. Be sure the side containing the oil grooves faces OUTWARD. See Fig. 5.
6. Coat each journal surface with clean engine lube oil; then, fit each lower bearing shell and its cap into place. Match the used shell halves according to their serial number recorded at disassembly, and match the caps according to their location number. If a new bearing shell is to be installed, record the serial number and location in the engine. Be sure the bearing lock-tab is seated in the cap and the cap is seated against the frame.

NOTE: *To facilitate assembly of the bearing caps into the frame, spread the frame slightly, using frame expander, Part 147X1314 (mechanical) or Part 147X1742 (hydraulic). Remove the expander before tightening the cap nuts and side bolts.*

7. Use new O-rings on the bearing-cap side bolts, and apply Lubriplate Spray Lube "A"*, GE Part 147X1614, to the O-rings and the washer face and threads of the bolts. Also apply Molykote G-n†, GE Part 147X1143-1, or Lubriplate to the threads

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*Product of Fiske Bros. Refining Co.

†Product of Dow Corning Corp.

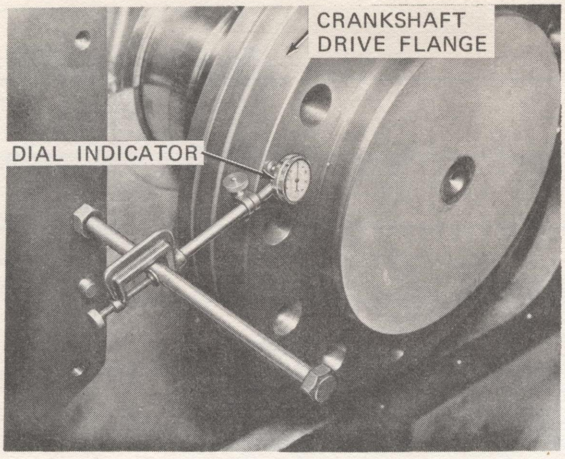

FIG. 14. CHECKING CRANKSHAFT THRUST CLEARANCE.

FIG. 14, E-9922

and contact face of the stud bolt nuts. While either lubricant is acceptable, less torque will be required when using Molykote to achieve the stretch value for the stud bolts.

Assemble the side bolts and stud bolt nuts finger tight. Further tighten the side bolts to approximately one-fourth the final recommended torque, finish tightening the stud bolt nuts by stretching the bolts to the value given in the DATA section, then finish tightening the side bolts to the torque value given in the DATA section.

8. Verify the crankshaft turns freely. If it does not, investigate each main bearing until the cause is found.

NOTE: *Main-bearing shells are precision-made parts. If an improperly-seated bearing shell is tightened in position, it will become permanently damaged. Bearings such as these, when removed, should be tagged and discarded to prevent them from being used accidentally.*

9. Check the crankshaft thrust clearance, using an accurate dial indicator readable to 0.001 in. Position the dial indicator as shown in Fig. 14. Using a pry bar against the web surface, pry the shaft to its extreme travel in one direction. Zero the indicator, then move the shaft to its other extreme and read the thrust clearance. For limits see TAB DE-4, CRANKSHAFT AND MAIN BEARINGS.

The frame may now be turned to its upright position in preparation for assembly of the oil pan and other component parts. See TAB DE-3, ENGINE COVERS AND OIL PAN. During final assembly of the engine, refer to the following painting instructions.

PAINTING ENGINE EXTERIOR

After the engine is completely assembled, the exterior surfaces should be painted, using the type of paint specified in the DATA section, or its equivalent. All exposed working surfaces such as fuel-injection-pump rack shafts and linkage bearings, overspeed butterfly-valve-actuator piston rods, and control-governor power shaft must not be painted. These parts, along with the turbocharger inlet and other openings and the crankshaft coupling flange, must be masked with paper or masking tape during painting.

DATA

MAIN FRAME

Material	Special cast iron	
Weight Including Bearing Caps	lb.	kg
16-cylinder Engine	11,800	5 352
12-cylinder Engine	9,300	4 218
Overall Dimensions		
Length	In.	mm
16-cylinder Engine	154-1/8	3 915
12-cylinder Engine	121-1/8	3 077
Width	60	1 524
Height	50-3/4	1 289
Main-Bearing Bores		
Bore Diameter*	8.751-8.750	222,28-222,25
Out-of-round (max.)	0.002	0,051

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*Average of 6 readings, 3 at each end of the bore, 120 degrees apart. When measuring main-bearing bores, cap nuts and side bolts must be tightened to their specified torque.

DATA (Cont'd.)

	In.	mm
**Bore Alignment:		
Vertical Misalignment (vertical step from bottom of one bore to bottom of adjacent bore) (max.)	0.0015	0,038
Vertical Bow Overall (bearing-bore centerline) (max.)		
16-cylinder	0.004	0,102
12-cylinder	0.003	0,076
Horizontal Misalignment (between adjacent main-bore centerlines) (max.)	0.002	0,051
Horizontal Bow Overall (bearing-bore centerlines) (max.)		
16-cylinder	0.006	0,152
12-cylinder	0.0045	0,114
Bore Width (between thrust bearings)	3.618-3.615	91,90-91,82
Camshaft-Bearing Bores		
Bore Diameter*	5.5005-5.4990	139,71-139,67
**Misalignment Between Adjacent Camshaft-Bore Centerlines (max.)	0.0025	0,064
Cylinder-Seat Bores	13.257-13.252	336,73-336,60
Crosshead Bores		
Bore Diameters (all crossheads)		
Upper	3.132-3.125	79,55-79,38
Lower	2.8755-2.873	73,04-72,97

TORQUE VALUES

	lb.-ft.	N·m
Core Plugs	350-375	475-508
Cylinder Mounting-Bolt Thread Inserts	375-400	508-542
Main-Bearing Caps		
Side Bolts	265-275	359-373
Cap Nuts – Assembly	Stretch stud bolt 0.027 to 0.033 in. (0,69 to 0,84 mm)	
Cap Nuts – Machining Bore	Stretch stud bolt 0.035 to 0.037 in. (0,89 to 0,94 mm)	
Lifting Lug Bolts	440-490	597-664

MATERIALS

Paint, Frame Exterior	Gray Enamel, Gliddens No. 54620 or Lowe Bros. No. C-17622

NOTE: *Equivalent paints, made by other manufacturers, also may be used.*

Cleaning Compounds

Manufacturer	Product
Turco Products, Inc.	Turco R.R. No. 1
Oakite Products, Inc.	Oakite R.R.
Magnus Chemical Company, Inc.	R.R. 755

NOTE: *Use the above cleaners according to directions supplied by the cleaner manufacturers. Equivalent cleaners, made by other manufacturers, also may be used.*

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*Average of 6 readings, 3 at each end of the bore, 120 degrees apart.

**Check bore alignments with the main frame set-up on blocks which set on a surface which is flat within 0.002 in. (0.051 mm) total tolerance. Blocks must be of same height with not more than 0.0005 in. (0,013 mm) deviation in the set. Position blocks under frame rails below Number 3 and 8 side bolt holes for a 16-cylinder frame; below Number 2 and 7 side bolt holes for a 12-cylinder frame.